

# **8 GeV Linac RF Distribution System**

**The RF System for the 8 GeV Linac is similar to TESLA.**

**One High-Powered Klystron feeds many cavities:**

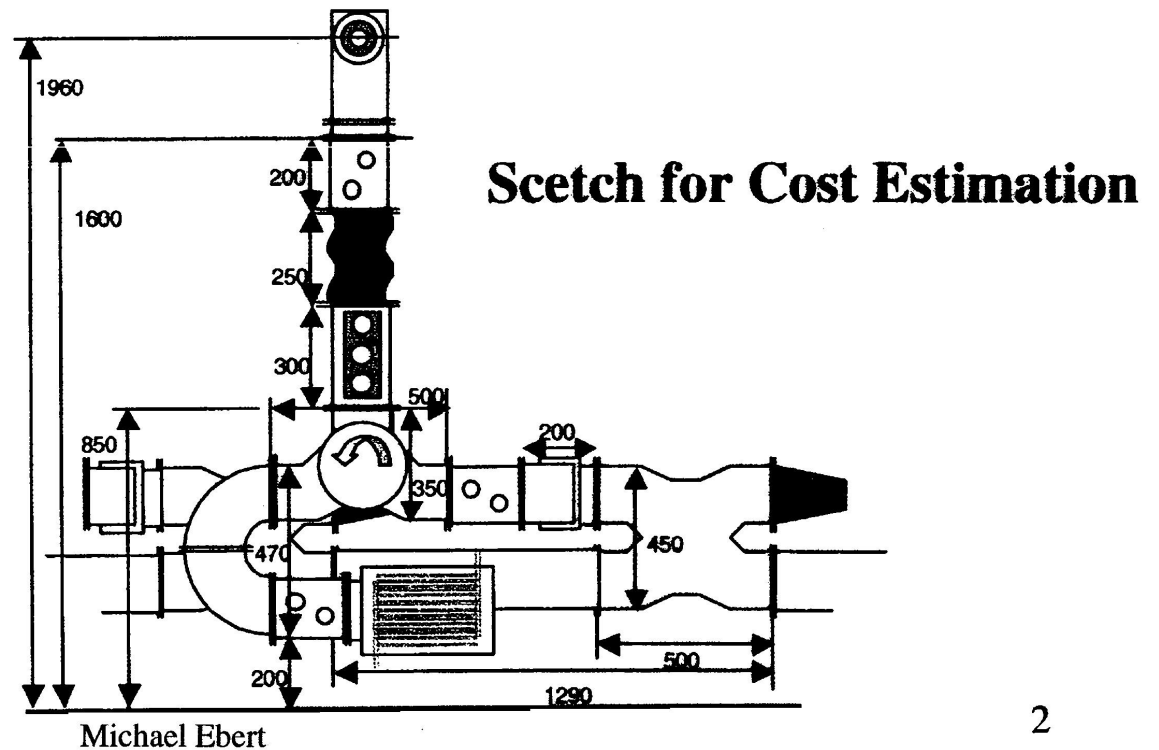
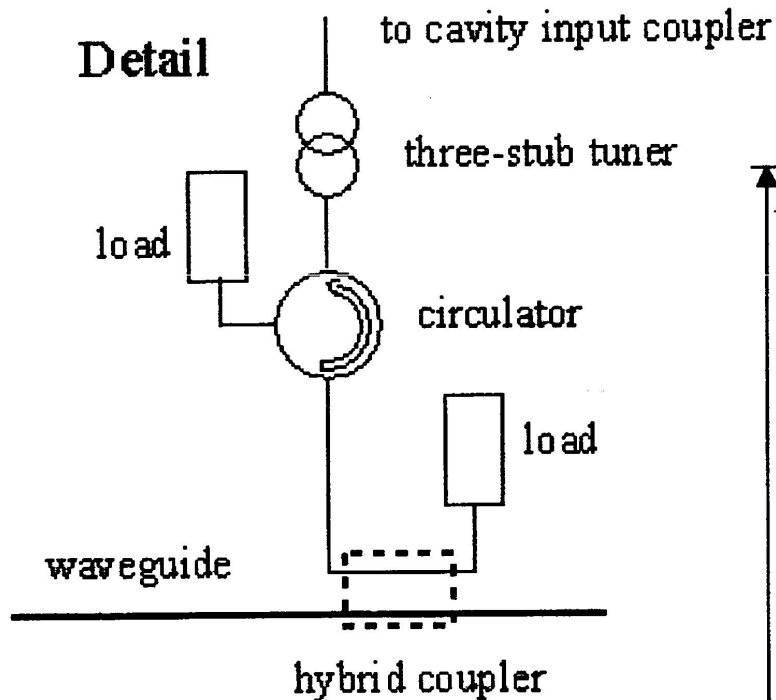
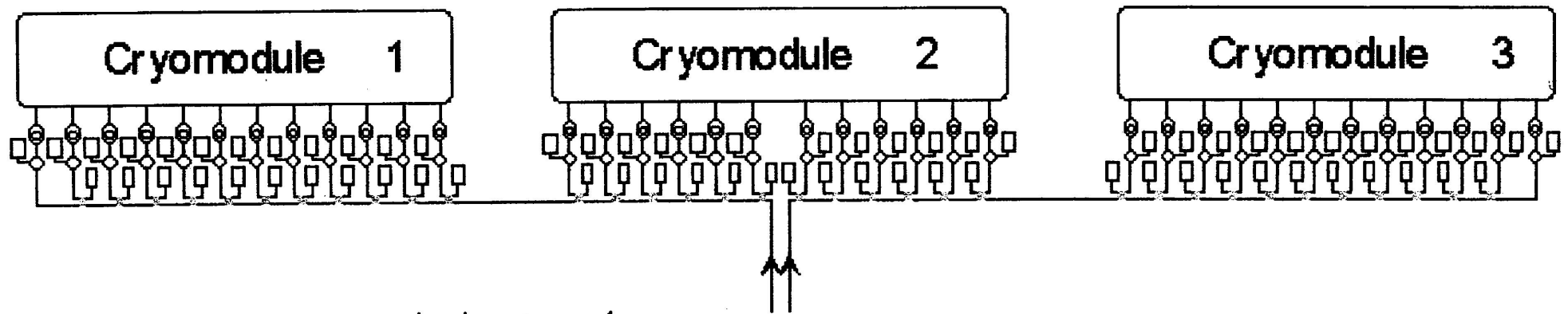
- 18-36 Cavities per Klystron in TESLA.
- 8-12 Cavities per Klystron in 8 GeV Linac.

**Differences between 8 GeV Linac and TESLA:**

- The 8 GeV Linac Klystrons are in an upstairs gallery.
- The mechanical 3-stub tuners in the TESLA design are replaced with electronically controlled E-H tuners.
- This gives the 8 GeV Linac control over the phase and amplitude of the drive of each individual cavity

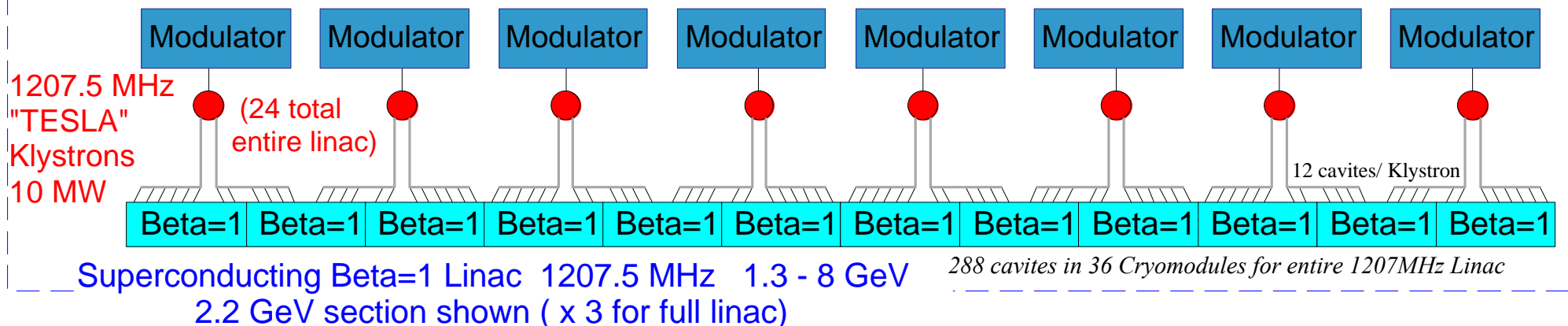
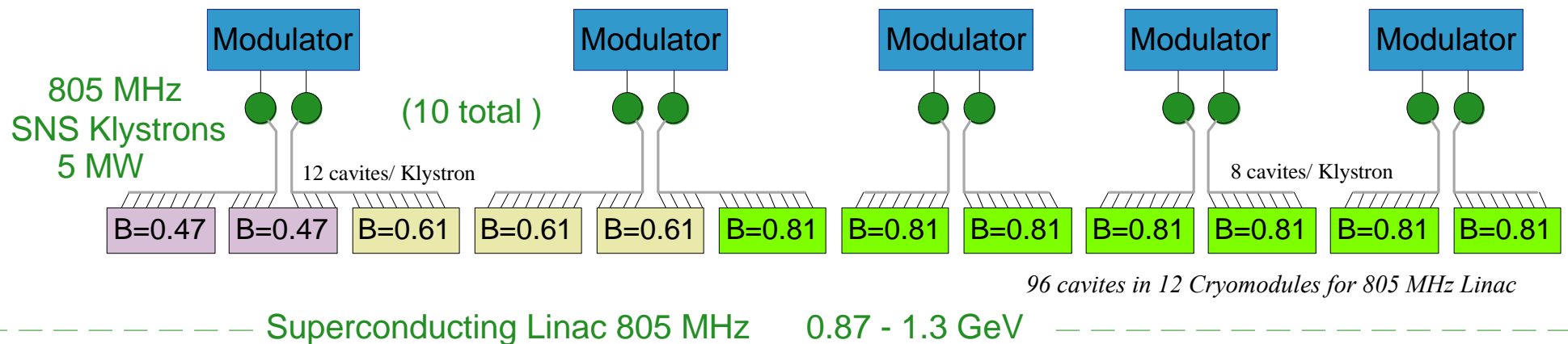
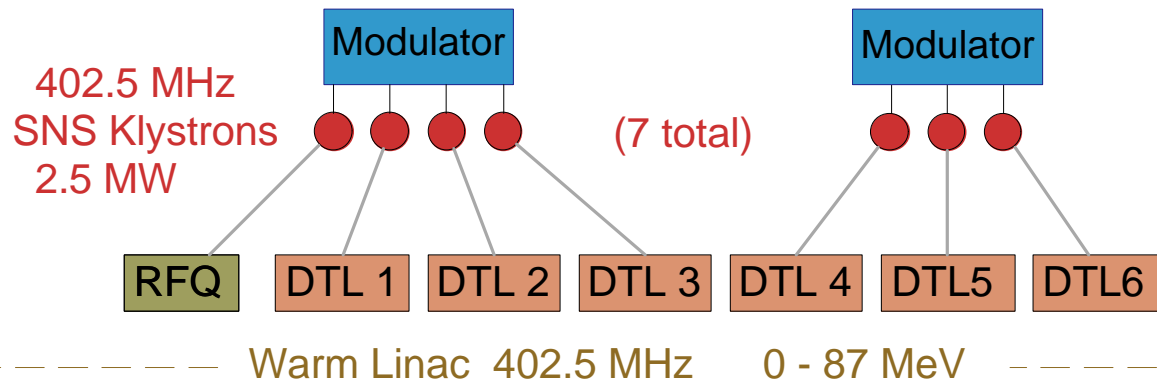
***8 GeV Linac accelerates both Protons and Electrons***

# TESLA RF POWER DISTRIBUTION



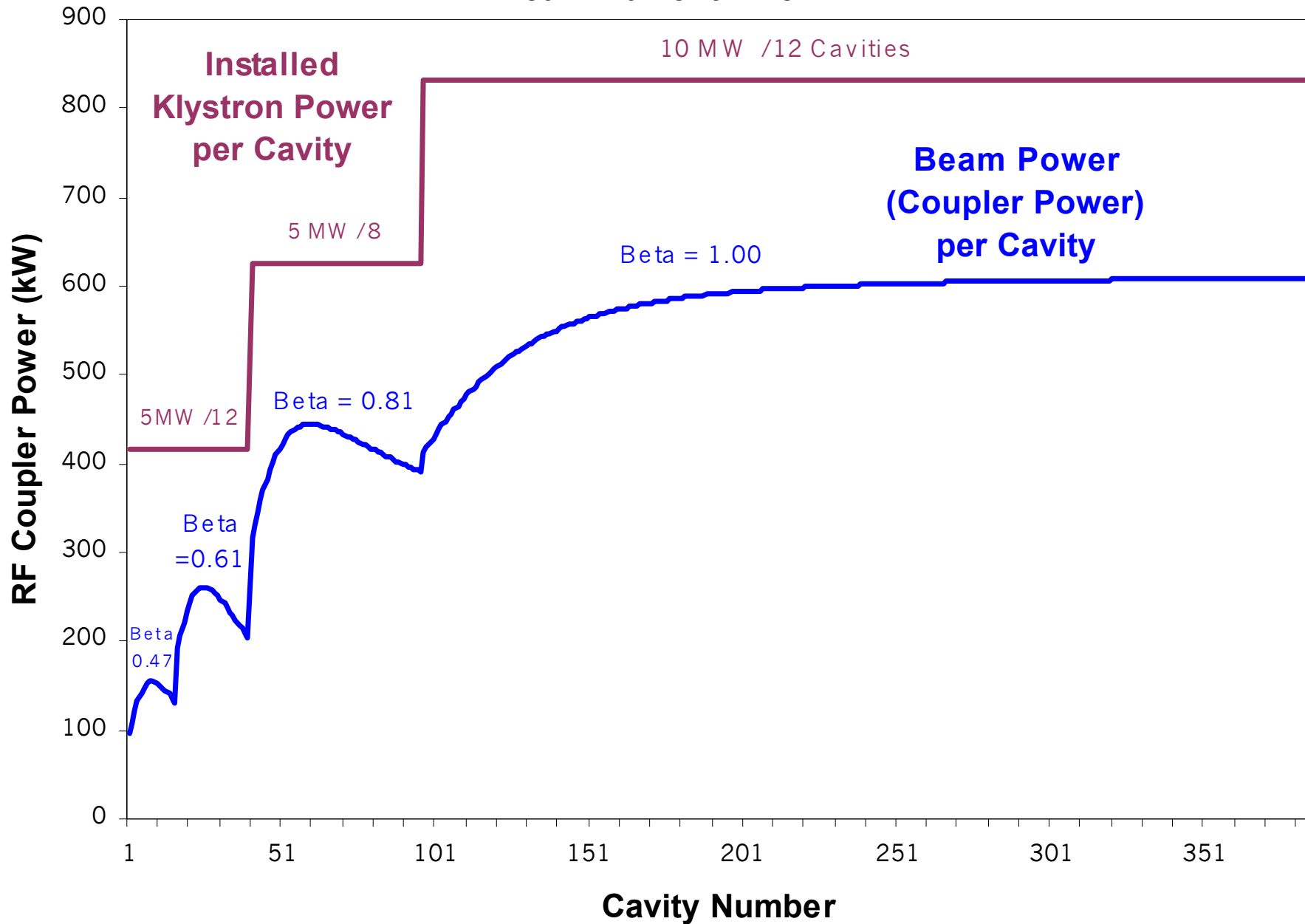
# 8 GeV RF LAYOUT

41 Klystrons (3 types)  
 31 Modulators 17 MW ea.  
 7 Warm Linac Loads  
 384 Superconducting Cavities  
 48 Cryomodules

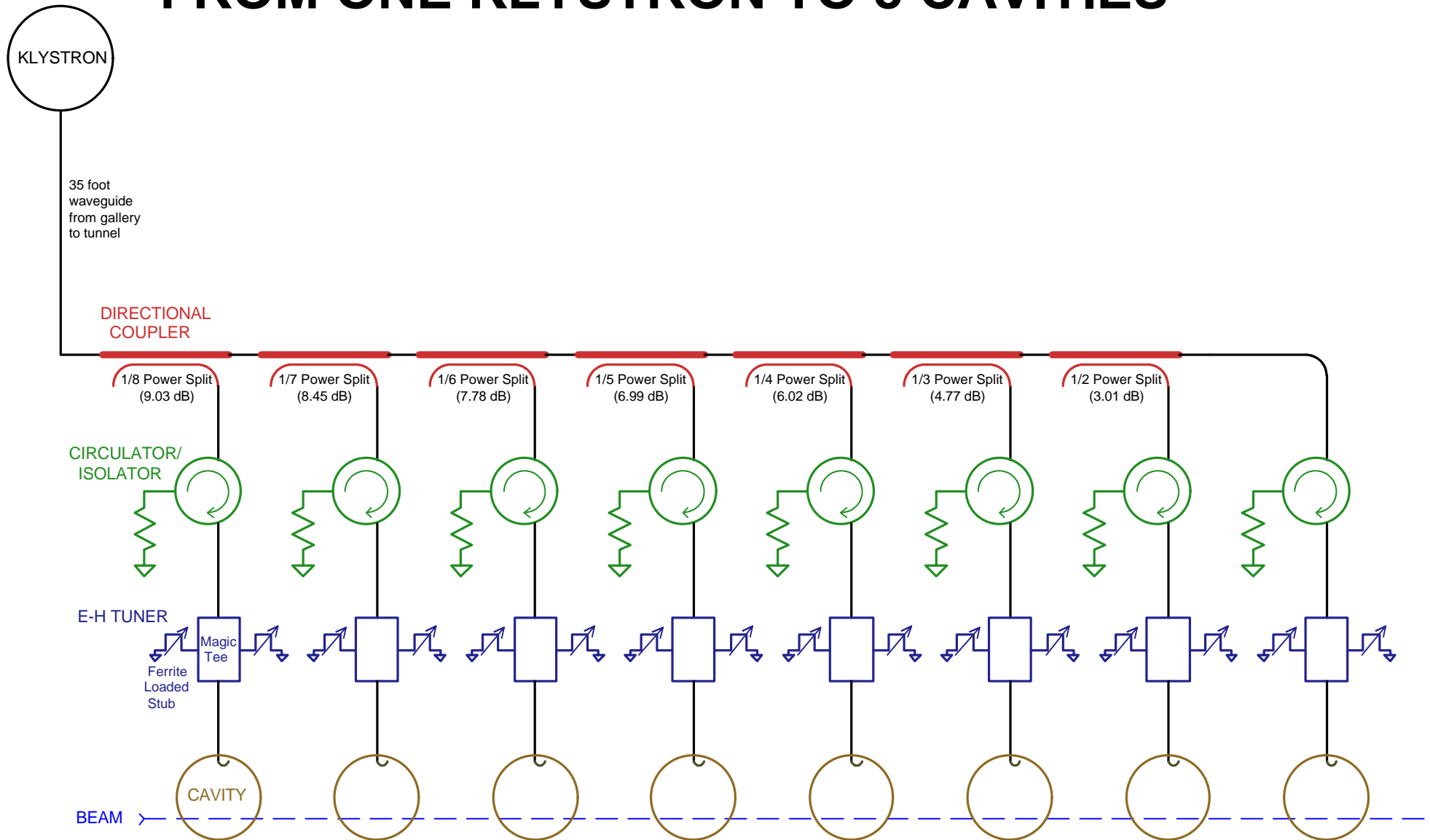


# Klystron Power and RF Coupler (Beam) Power

Epeak = 45MV/m in all cavities, Phi\_Synch = -25 to -16 degrees  
Beam Current = 25mA



# TYPICAL RF FANOUT FROM ONE KLYSTRON TO 8 CAVITIES





## KLYSTRON

- RF Power Source
- Located in Gallery above tunnel
- Each Klystron Feeds 8-16 Cavities

35 foot  
waveguide  
from gallery  
to tunnel

DIRECTIONAL  
COUPLER

## DIRECTIONAL COUPLER

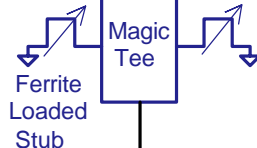
- Picks of a fixed amount of RF power at each station
- Passes remaining power downstream to other cavities

CIRCULATOR/  
ISOLATOR

## CIRCULATOR / ISOLATOR

- Passes RF power forward towards cavity
- Diverts reflected power to water cooled load

E-H TUNER



## E-H TUNER

- Provides Phase and Amplitude Control for Cavities
- Biased Ferrite Provides Electronic Control



## SUPERCONDUCTING RF CAVITY

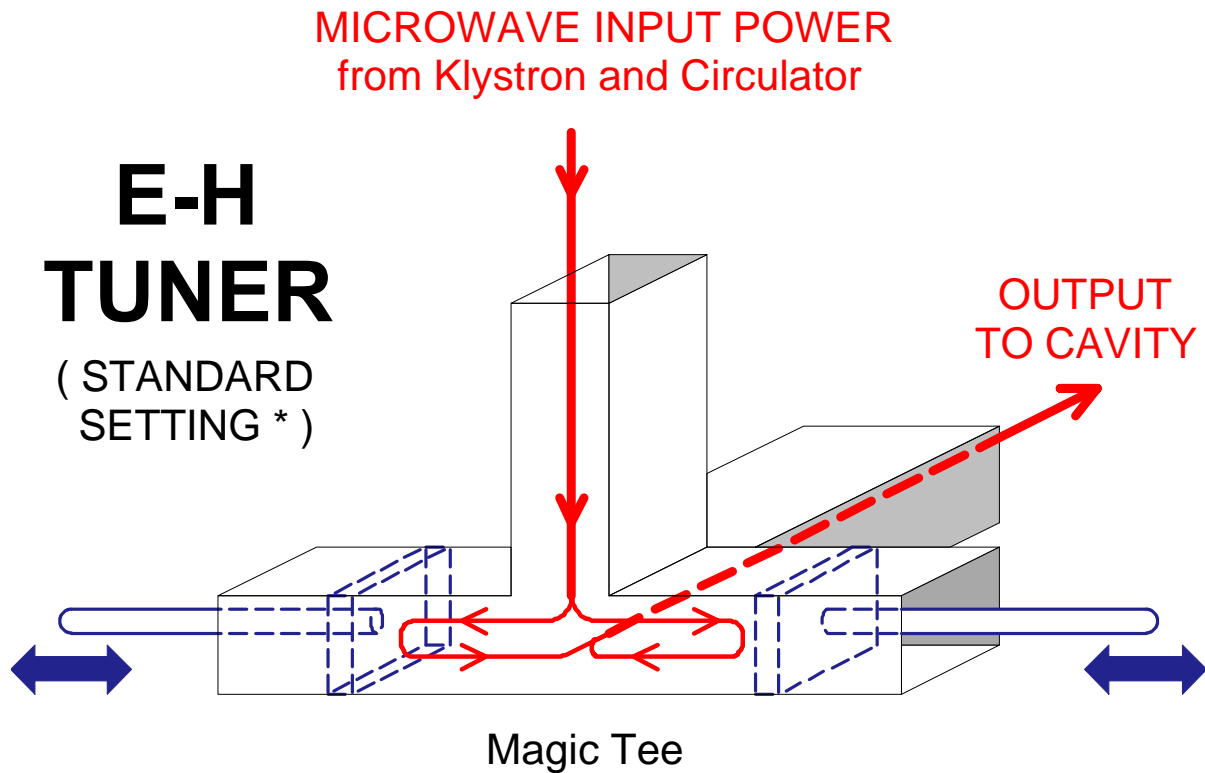
- Couples RF Power to Beam

BEAM



# HOW DOES AN E-H TUNER WORK?

## *1. PHASE ADJUSTMENT*



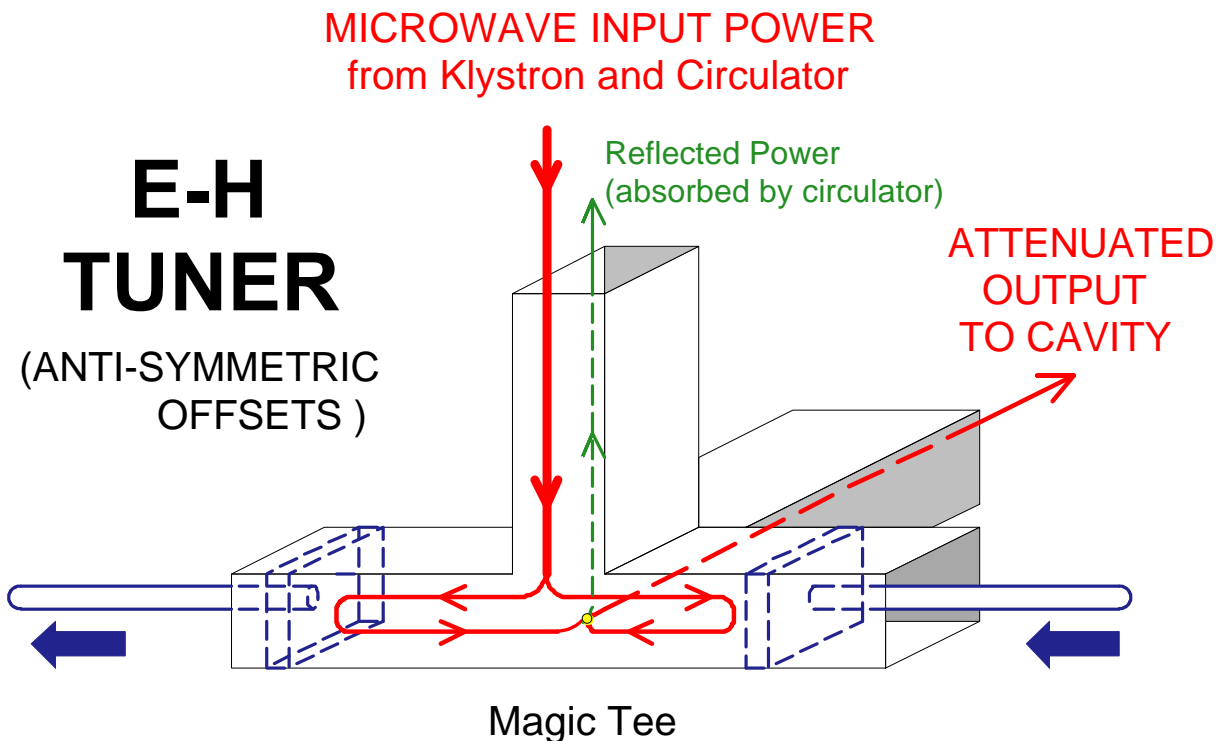
MICROWAVE POWER IS SPLIT INTO TWO INSIDE MAGIC TEE, REFLECTED FROM TWO ADJUSTABLE SHORTING STUBS, AND RECOMBINED AT OUTPUT PORT

***PHASE CHANGE OF OUTPUT*** IS PRODUCED BY  
***SYMMETRIC*** MOTION OF TWO TUNING ARMS

\* “Standard Setting” actually requires  $\lambda_g/4$  offset between legs

# HOW DOES AN E-H TUNER WORK?

## ***2. AMPLITUDE ADJUSTMENT***

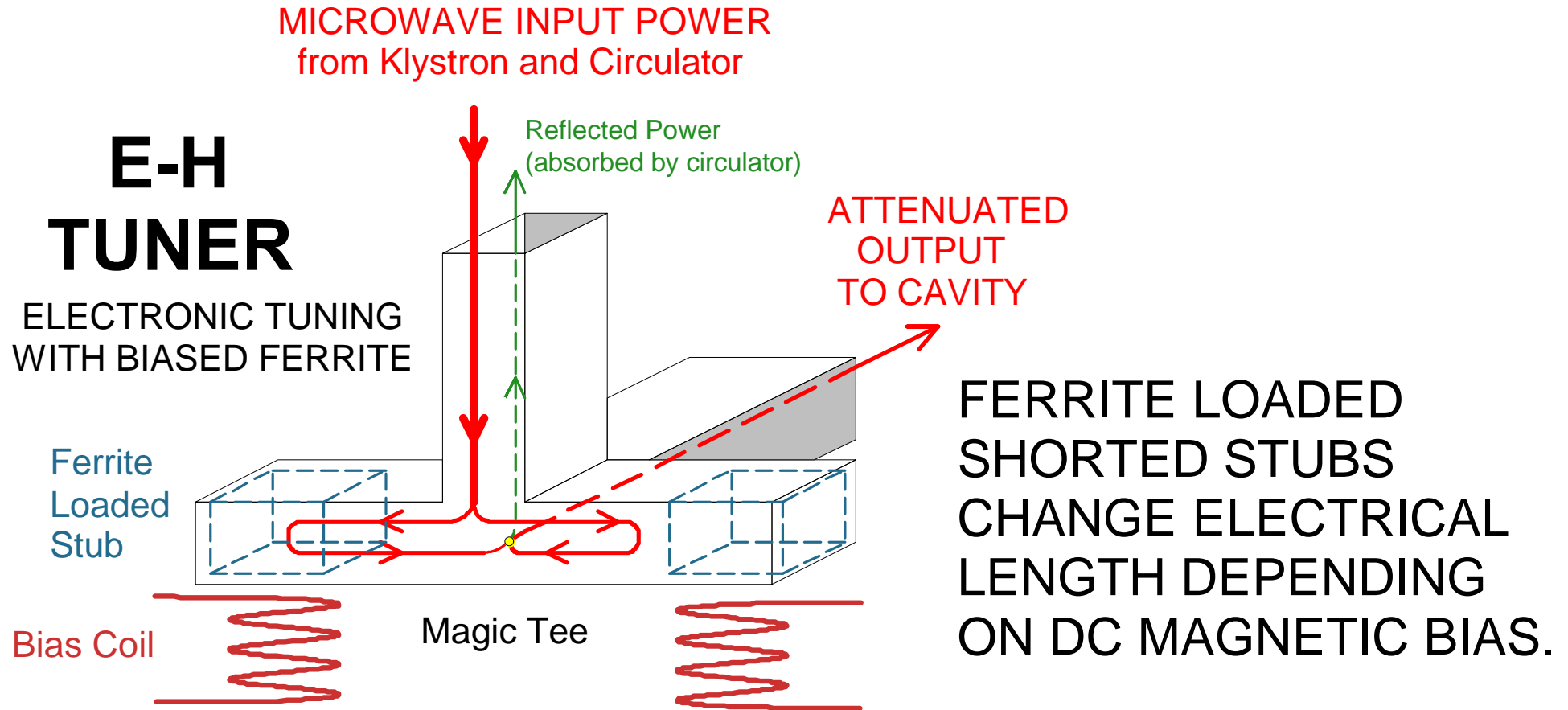


ASYMMETRIC OFFSETS OF SHORTING STUBS CAUSES FRACTION OF MICROWAVE POWER TO RECOMBINE INTO OUTPUT PORT, PLUS SOME REFLECTED POWER TO INPUT PORT. (REFLECTED POWER IS EATEN BY CIRCULATOR).

***AMPLITUDE CHANGE*** IS PRODUCED BY  
***ANTI-SYMMETRIC*** OFFSETS OF TWO TUNING ARMS



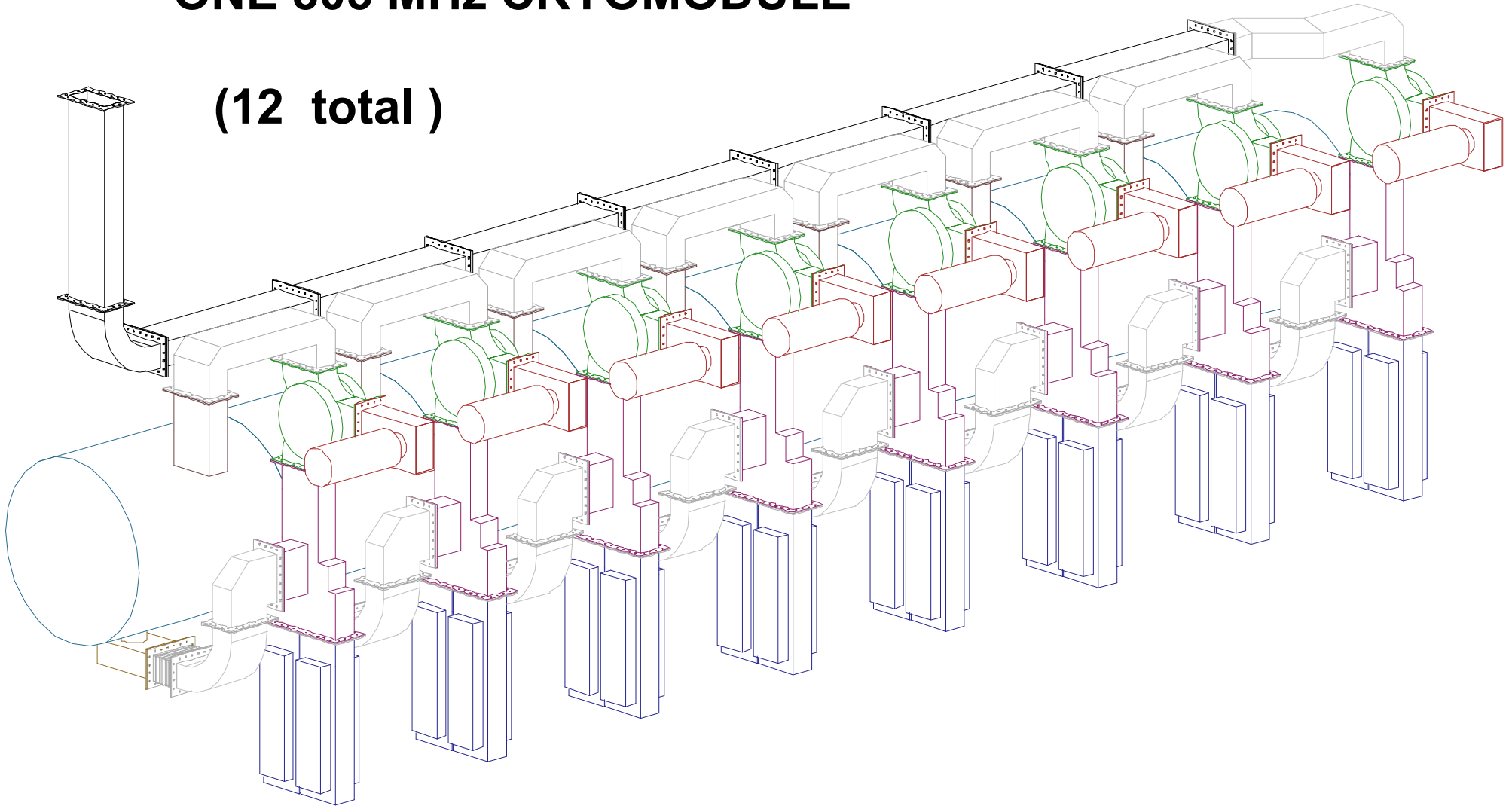
# ELECTRONICALLY ADJUSTABLE E-H TUNER



**TWO COILS** PROVIDE INDEPENDENT  
**PHASE AND AMPLITUDE** CONTROL OF CAVITIES

# RF DISTRIBUTION FOR ONE 805 MHz CRYOMODULE

(12 total )



## WAVEGUIDE TUNER OPTION

For the “Waveguide Tuner” option, the tuners consist of ferrite-loaded shorted stubs of waveguide with bias electromagnets to control the phase shift in each arm of the E-H tuner.

# FRONT VIEW

805 MHz POWER  
DISTRIBUTION  
LINE (WR-1150)

DIRECTIONAL  
COUPLER  
FOR POWER  
FAN OUT

CIRCULATOR  
805 MHz

WATER LOAD  
TERMINATOR  
(600 kW peak,  
6 kW avg)

CRYOSTAT FOR  
SUPERCONDUCTING  
CAVITIES

MAGIC TEE

RF COUPLER  
TO CAVITY

FAST FERRITE  
PHASE SHIFTERS  
FOR CAVITY  
PHASE AND  
AMPLITUDE  
CONTROL

## WAVEGUIDE TUNER OPTION

# SIDE VIEW

FROM  
805 MHz  
KLYSTRON

DIRECTIONAL COUPLER  
1/8 Power Split

1/7 Power Split ...

CIRCULATOR

WATER  
LOAD

MAGIC  
TEE

MAGIC  
TEE

120in

RF CAVITY  
COUPLER

RF CAVITY  
COUPLER

WAVEGUIDE  
TUNER  
OPTION

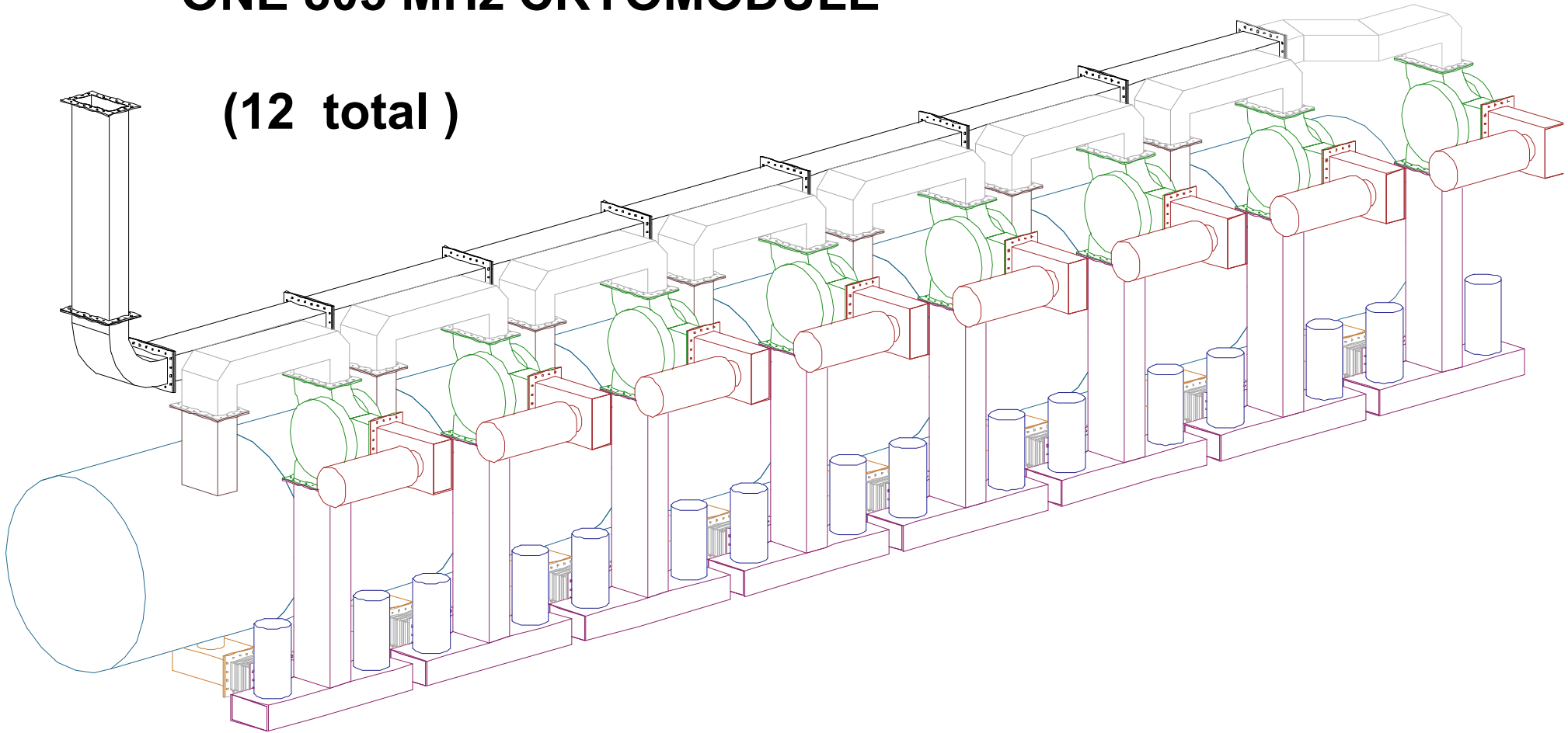
FERRITE  
PHASE  
SHIFTERS

FERRITE  
PHASE  
SHIFTERS

48 in (typ.)

# RF DISTRIBUTION FOR ONE 805 MHz CRYOMODULE

(12 total )



## COAXIAL TUNER OPTION

For the “Coaxial Tuner” option, the shorted stubs consist of waveguide-to-coaxial transitions, with short ferrite-loaded coaxial stubs with bias solenoids to control the phase shift.

# FRONT VIEW

805 MHz POWER  
DISTRIBUTION  
LINE (WR-1150)

DIRECTIONAL  
COUPLER  
FOR POWER  
FAN OUT

CIRCULATOR  
805 MHz

WATER LOAD  
TERMINATOR  
(600 kW peak,  
6 kW avg)

CRYOSTAT FOR  
SUPERCONDUCTING  
CAVITIES

FERRITE COAXIAL  
PHASE SHIFTERS  
FOR CAVITY  
PHASE AND  
AMPLITUDE  
CONTROL

RF COUPLER  
TO CAVITY

MAGIC TEE

COAXIAL TUNER OPTION

# SIDE VIEW

FROM  
805 MHz  
KLYSTRON

DIRECTIONAL COUPLER  
1/8 Power Split

1/7 Power Split ...

CIRCULATOR

WATER  
LOAD

DAOL

FERRITE  
COAXIAL  
PHASE  
SHIFTERS

FERRITE  
COAXIAL  
PHASE  
SHIFTERS

MAGIC  
TEE

M  
T

120in

COAXIAL TUNER OPTION

48 in (typ.)